

LAND SUBSIDENCE IN THE UNITED STATES

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U.S. Geological Survey
Circular 1182
1999

U.S. DEPARTMENT OF THE INTERIOR

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Secretary

U.S. GEOLOGICAL SURVEY

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Director

Reston, Virginia 1999

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Free on application to the

U.S. Geological Survey
Information Services
Box 25286
Denver, CO 80225-0286

Library of Congress Cataloging-in-Publication Data

Land subsidence in the United States / edited by Devin Galloway, David R. Jones, S.E. Ingebritsen.

p. cm. — (U.S. Geological Survey Circular; 1182)

Includes bibliographical references.

ISBN 0-607-92696-1

1. Subsidence (Earth movements)—United States—Case studies.

2. Groundwater—United States—Case studies I. Galloway, Devin L.

II. Jones, David R. (David Richard) III. Ingebritsen, S.E. IV. Series.

QE600.3.U6.L36 1999
551.3'07'0973—dc21

99-040089

Foreword



Sacramento/San Joaquin River Delta

From the San Francisco Bay/Delta to the Florida Everglades and from upstate New York to Houston, people are dealing with a common problem in these diverse locations—land subsidence due to the withdrawal of ground water or the application of water at the land surface. These locations illustrate that subsidence is not an isolated problem: an area of more than 15,000 square miles in 45 States experience land subsidence. Using these locations and others as case studies, this report focuses on three principal processes causing land subsidence: the compaction of aquifer systems, the oxidation of organic soils, and the collapse of cavities in carbonate and evaporite rocks. The impacts of land subsidence, past and present, are illustrated, and most importantly, so is the value of science in effectively limiting damages from land subsidence.

An important aspect of the USGS mission is to provide information that describes the Earth, its resources, and the processes that govern the availability and quality of those resources. With reports such as this Circular, the USGS seeks to broaden public understanding of land subsidence as an Earth process, and the serious impacts that subsidence can cause if those impacts are not understood, anticipated, and properly managed. By applying scientific understanding and engineering approaches to problems of land subsidence, our society will have solutions that can mitigate or eliminate the negative impacts of subsidence while allowing continued beneficial uses of water. It is our hope that this information will be helpful for concerned citizens, landowners, water users, water managers, and officials responsible for public investments and regulation of land and water use.

For some readers, this report will be an end in itself in providing an understanding of the phenomena of land subsidence that satisfies their need to act as informed citizens or decision makers, or simply to satisfy their curiosity about an important Earth process. For other readers, we hope this report will be a gateway to the rich scientific literature on the subject of subsidence and strategies for the control of subsidence, through the references provided.

Scientific understanding is critical to the formulation of balanced decisions about the management of land and water resources. This Circular coupled with ongoing data collection, basic research, and applications of that research to specific subsidence problems, constitute the USGS contribution toward wise management of land subsidence as a part of effective and publicly beneficial land- and water-management strategies.

Robert M. Hirsch

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Associate Director for Water Resources



Fissure, South-Central Arizona

Acknowledgments

We are particularly indebted to four U.S. Geological Survey colleagues who assisted in the planning and research that led to this report. Keith Prince, Stan Leake and Tom Holzer, long-time proponents of the scientific understanding of subsidence problems related to ground-water use, launched this effort. Francis Riley, a pioneer in field studies of land subsidence related to ground-water extraction, counselled us extensively on aquifer-system compaction.

We are also especially grateful to the many key colleagues and cooperators who generously lent their expertise to review technical and nontechnical aspects of each of the case studies: Behzad Ahmadi, Tom Iwamura, and Cheryl Wessling (Santa Clara Valley Water District), and Eric Reichard (U.S. Geological Survey) for Santa Clara Valley, California; Gil Bertoldi (U.S. Geological Survey, retired), George Davis (U.S. Geological Survey, retired) and Harvey Swanson (California Division of Water Resources, retired) for San Joaquin Valley, California; Robert Gabrysch (U.S. Geological Survey, retired), and Ron Neighbors (Harris-Galveston Coastal Subsidence District) for Houston-Galveston, Texas; John Bell (Nevada Bureau of Mines and Geology), Gary Dixon (U.S. Geological Survey), and Michael Johnson (Las Vegas Valley Water District) for Las Vegas Valley, Nevada; Stan Leake (U.S. Geological Survey), and Herb Schumann (U.S. Geological Survey, retired) for Southern Arizona; Margit Aramburu (Delta Protection Commission), Lauren Hastings (U.S. Geological Survey), and M. Mirmazaheri (California Department of Water Resources) for the Sacramento-San Joaquin River Delta, California; Jud Harvey (U.S. Geological Survey), Carol Kendall (U.S. Geological Survey), and Jayantha Obeysekera (South Florida Water Management District) for the Florida Everglades; Jim Borchers (U.S. Geological Survey), Kathy Sanford (New York State Department of Environmental Conservation) and Richard Young (State University New York—Geneseo) for the Retsof Salt Mine Collapse, New York; and Mark Barcelo (Southwest Florida Water Management District), Craig Hutchinson (U.S. Geological Survey), William L. Wilson (Subsurface Evaluations Inc.), and Dan Yobbi (U.S. Geological Survey) for West-Central Florida. We are also grateful to our U.S. Geological Survey colleagues, Charles Heywood and Steven Phillips, for thorough and thoughtful reviews of the final chapter, Role of Science. Finally we thank Michelle Sneed (U.S. Geological Survey) for her final read-through of the Circular and for her constructive comments.



Cover-collapse sinkhole, West-Central Florida

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Conversions

This Circular uses English units. To determine metric values use the conversion factors listed below.

MEASUREMENT	MULTIPLY	BY	TO OBTAIN
Length	inch	25.4	millimeter
	foot	0.3048	meter
	mile	1.609	kilometer
Area	square foot	0.09290	square meter
	square mile	2.590	square kilometer
	acre	0.4047	hectare
Volume	acre foot	1233	cubic meter
	cubic foot	0.02832	cubic meter
	gallon	3.785	liter
Mass	ounce	28.35	gram
	pound	0.4536	kilogram
	ton (short)	0.9072	megagram
Temperature	degree Fahrenheit	$\frac{^{\circ}\text{F}-32}{1.8}$	degree Celsius

Vertical Datum

In this report, “sea level” refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called “Sea Level Datum of 1929.”

“Mean sea level” is not used with reference to any particular vertical datum; where used, the phrase means the average surface of the ocean as determined by calibration of measurements at tidal stations.